FORM PTO-1390 (Modified) (REV 11-98) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U S APPLICATION NO (IF KNOWN, SEE 37 CFR
19036/37126	09/786565

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP99/04976	September 10, 1999	September 17, 1998

TITLE OF INVENTION
LIGHT DIFFUSING SHEET AND BACKLIGHT UNIT USING THIS

APPLICANT(S) FOR DO/EO/US
Yutaka Mineo

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C 371
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C 371(b) and PCT Articles 22 and 39(1)
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau)
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C 371(c)(2))
7. ☐ A copy of the International Search Report (PCT/ISA/210)
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made, however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☒ Certificate of Mailing by Express Mail
20. ☐ Other items or information:

U.S. APPLICATION NO (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/786565	PCT/JP99/04976	19036/37126

21. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1 482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO . . .	$1,000.00
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO . . .	$860.00
☐	International preliminary examination fee (37 CFR 1 482) not paid to USPTO but international search fee (37 CFR 1 445(a)(2)) paid to USPTO . . .	$710.00
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) . . .	$690.00
☐	International preliminary examination fee paid to USPTO (37 CFR 1 482) and all claims satisfied provisions of PCT Article 33(1)-(4) . . .	$100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	7 - 20 =	0	x $18.00	**$0.00**	
Independent claims	3 - 3 =	0	x $80.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$860.00**	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable)**.			☐	**$0.00**	
SUBTOTAL =				**$860.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)) +				**$0.00**	
TOTAL NATIONAL FEE =				**$860.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			☐	**$0.00**	
TOTAL FEES ENCLOSED =				**$860.00**	
				Amount to be: refunded	$
				charged	$

☒ A check in the amount of **$860.00** to cover the above fees is enclosed

☐ Please charge my Deposit Account No. in the amount of to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **13-2855** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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March 7, 2001
DATE

DESCRIPTION

LIGHT DIFFUSING SHEET AND BACKLIGHT UNIT USING THIS

[Technical Field]

The present invention relates to a light diffusing sheet used in a backlight unit incorporated into a liquid crystal display and a backlight unit using the light diffusing sheet.

[Background Art]

Conventionally, as a backlight unit incorporated into a liquid crystal display, there has been used a backlight unit comprising a lamp as a source for generating light rays, a light guiding plate disposed laterally of the lamp for guiding the light rays emitted from the lamp toward a front surface side, and a light diffusing sheet formed on a front surface side of the light guiding plate (on a screen side of the liquid crystal display).

As the light diffusing sheet, there has been proposed a light diffusing sheet comprising a light diffusing layer formed by applying a resinous composition including dispersed resinous beads on a surface of a base sheet made of synthetic resin such as polyethylene terephthalate (see Japanese Utility Model

Publication No. Hei 5-73602). In this light diffusing sheet, the light rays transmitted through the light diffusing layer can be uniformly diffused by the resinous beads, resulting in enhanced luminance of the screen of the liquid crystal display.

To suppress partial adhesion (sticking) between a rear surface of the light diffusing sheet and a front surface of the light guiding plate and to thereby prevent a luminance nonuniformity of the screen, there has been proposed a light diffusing sheet comprising a sticking-proof layer formed by applying a resinous composition including dispersed resinous beads on a rear surface of a base sheet (for example, see Japanese Utility Model Publication No. Hei 7-8803).

By the way, these light diffusing sheets have a drawback in that these sheets are subject to deformation due to heat because the base sheets are made of the synthetic resin. On the other hand, the lamp as the source for generating light rays is adapted to emit light and generate heat simultaneously. In general, a portion of the light diffusing sheet in the vicinity of the lamp is exposed to temperatures of approximately 80 to 90°C. For this reason, the light diffusing sheet is thermally deformed and partially deflected. The deflection causes the luminance

nonuniformity of the screen.

[Disclosure of the Invention]

The present invention has been developed for the purpose of obviating the above-described problem, and an object of the present invention is to provide a light diffusing sheet that has a less tendency to be deflected due to heat generated by a lamp and a backlight unit using this.

To solve the above-described problem, there is provided a light diffusing sheet comprising: a transparent base sheet; and a light diffusing layer provided on a surface of the base sheet, wherein the light diffusing layer is formed by dispersing resinous beads and a fine inorganic filler into a binder, and the fine inorganic filler is colloidal silica.

According to this invention, since the resinous beads and the fine inorganic filler as light diffusing materials are contained in the binder of the light diffusing layer, an apparent crystallinity index of the light diffusing sheet is increased and heat resistance is improved. Consequently, the deflection of the light diffusing sheet can be suppressed.

In the light diffusing sheet, the resinous beads of the light diffusing layer have an averaged

particle diameter of 1 micrometer to 50 micrometers and the fine inorganic filler of the light diffusing layer has an averaged particle diameter of not smaller than 5 nanometers and smaller than 1 micrometer.

Thereby, the deflection of the light diffusing sheet can be suppressed while maintaining a preferable light diffusing ability. In addition, the amount of the fine inorganic filler mixed into the light diffusing layer is 10 parts to 500 parts by weight for 100 parts by weight of a polymer component in the binder. Thereby, the heat resistance of the light diffusing sheet and the easiness of fabrication operation of the light diffusing sheet can be achieved. When using the colloidal silica as the fine inorganic filler, the application operation of the resinous composition forming the light diffusing layer can be simplified as mentioned later.

To solve the above-described problem, there is further provided a light diffusing sheet comprising: a transparent base sheet; a light diffusing layer provided on a front surface side of the base sheet; and a sticking-proof layer provided on a rear surface side of the base sheet, wherein the sticking-proof layer is formed by dispersing resinous beads and a fine inorganic filler into a binder, and the fine inorganic

filler is colloidal silica.

According to this invention, since the resinous beads and the fine inorganic filler as light diffusing materials are contained in the binder of the sticking-proof layer, the apparent crystallinity index of the light diffusing sheet is increased and heat resistance is improved. Consequently, the deflection of the light diffusing sheet can be suppressed.

In the light diffusing sheet, the resinous beads of the sticking-proof layer have an averaged particle diameter of 1 micrometer to 50 micrometers and the fine inorganic filler of the light diffusing layer has an averaged particle diameter of not smaller than 5 nanometers and smaller than 1 micrometer.

Thereby, the deflection of the light diffusing sheet can be suppressed while maintaining a preferable sticking-proof ability. In addition, the amount of the fine inorganic filler mixed into the sticking-proof layer is 10 parts to 500 parts by weight for 100 parts by weight of a polymer component in the binder. Thereby, the heat resistance of the light diffusing sheet and the easiness of fabrication operation of the light diffusing sheet can be achieved. When using the colloidal silica as the fine inorganic filler, the application operation of the resinous

composition forming the sticking-proof layer can be simplified as mentioned later.

These light diffusing sheets are less deflected due to heat, and if the backlight unit is formed by using this, the luminance nonuniformity of the liquid crystal display can be suppressed.

[Brief Description of the Drawings]

Figure 1 is a cross-sectional view in which a light diffusing sheet of an embodiment of the present invention is partially omitted;

Figure 2 is a schematic view for explaining a structure of a backlight unit into which the light diffusing sheet of Figure 1 is incorporated; and

Figure 3 is a cross-sectional view in which a light diffusing sheet of another embodiment of the present invention is partially omitted.

[Best Mode for Carrying Out the Invention]

Hereinafter, the present invention will be described with reference to Figures.

Figure 1 is a cross-sectional view in which a light diffusing sheet 1 of an embodiment of the present invention is partially omitted. In Figure 1, an upper side corresponds to a front surface side (screen side

of a liquid crystal display) and a lower side corresponds to a rear surface side. The light diffusing sheet 1 comprises a base sheet 3 and a light diffusing sheet 5 provided on a surface of the base sheet 3.

The base sheet 3 is made of synthetic resin such as polyethylene terephthalate, polyethylene naphthalate, acrylic resin, polycarbonate, polystyrene, polyolefin, cellulose acetate, weather-resistant vinyl chloride. The base sheet 3 is transparent because it needs to transmit light rays and is preferably transparent and colorless. The thickness of the base sheet 3 is not limited and set to 50 to 250 micrometers, for example. If the thickness of the base sheet 3 is less than the above range, curling tends to occur in application of a resinous composition forming the light diffusing layer 5. On the other hand, if the thickness of the base sheet 3 is more than the above range, the luminance of the liquid crystal display is reduced, and the thickness of the backlight unit 13 is increased, which is contrary to requirements for a thinner liquid crystal display.

The light diffusing layer 5 is constituted by a binder 7, resinous beads 9 dispersed into the binder 7, and a fine inorganic filler 11 dispersed into the

binder 7. The dispersion of the fine inorganic filler 11 into the light diffusing layer 5 increases an apparent crystallinity index of the light diffusing sheet 1. Consequently, heat-resistance of the light diffusing sheet 1 is improved and deflection of the sheet 1 is suppressed. In addition, the dispersion of the resinous beads 9 into the light diffusing layer 5 allows light rays transmitted from a rear surface side to a front surface side to be uniformly diffused. Some of the resinous beads 9 have upper end portions protruded from the binder 7. The provision of the resinous beads 9 embedded in the binder 7 and the beads 9 having upper end portions protruded therefrom can greatly diffuse the light rays. The thickness of the light diffusing layer 5 (thickness of the binder 7 except the resinous beads 9 that is represented by Ti in Figure 1) is not limited and is set to approximately 10 to 30 micrometers, for example.

The reason why the dispersion of the fine inorganic filler 11 increases the apparent crystallinity index of the light diffusing sheet 1 is unclear but might be that the fine inorganic filler 11 exhibits behavior similar to that of a crystalline portion of a crystalline polymer and prevents thermal movement of a molecular chain of a polymer used for the

binder.

As examples of the polymer used for the binder 7, there are acrylic-based resin, polyurethane, polyester, fluorine-based resin, silicone based resin, polyamide, epoxy resin, and the like. In addition to the above polymers, elasticizer, stabilizer, degradation inhibitor, dispersant, anti-static additive, and the like may be mixed into the binder 7. The binder 7 is transparent because it needs to transmit light rays and is preferably colorless and transparent.

The resinous beads 9 are substantially sphere-shaped. The materials of the resinous beads 9 are acrylic resin, polyurethane, polyvinyl chloride, polystyrene, polyacrylonitrile, polyamide, and the like. The resinous beads 9 are preferably transparent for a larger amount of the light rays transmitted through the light diffusing sheet 1 and are more preferably colorless and transparent.

The averaged particle diameter of the resinous beads 9 is preferably 1 to 50 micrometers and is more preferably 2 to 20 micrometers. If the averaged particle diameter is less than the above range, an unsatisfactory light diffusing effect is provided, whereas if the averaged particle diameter is

larger than the above range, the application of the resinous composition forming the light diffusing layer 5 becomes difficult. The averaged particle diameter of the resinous beads 9 is derived by enlarging arbitrarily extracted 100 resinous beads 9 by using a microscope to measure particle diameters and by simply averaging the measured particle diameters. When the resinous beads 9 are not sphere-shaped, dimensions of the resinous beads 9 in an arbitrary direction and dimensions of the resinous beads 9 in a direction orthogonal to the arbitrary direction are averaged and the resulting averaged value is deemed as the particle diameter of the resinous beads 9.

The amount of the resinous beads 9 mixed into the light diffusing layer 5 is preferably 10 to 500 parts by weight for 100 parts by weight of a polymer component in the binder 7 and is more preferably 10 to 300 parts by weight. If the amount of the mixed resinous beads 9 is less than the above range, the light diffusion effect is unsatisfactorily provided, whereas the amount of the mixed beads 9 is more than the above range, the application of the resinous composition for forming the light diffusing layer 5 becomes difficult.

The fine inorganic filler 11 is, for example,

colloidal silica, smectite, colloidal magnesium carbonate, mica, and the like. Among these fine inorganic fillers 11, the colloidal silica is preferable, because if stirring of the resinous composition forming the light diffusing layer 5 is interrupted, the viscosity of the resinous composition is not greatly increased, and therefore adjusting operation or application operation of the resinous composition is easy.

To prevent loss of the light rays transmitted through the light diffusing sheet 1, it is preferable that the averaged particle diameter of the fine inorganic filler 11 is made as small as possible. Specifically, the averaged particle diameter is preferably smaller than 1 micrometer and is 400 nanometers or smaller corresponding to not larger than a visible wavelength of light. Further, the averaged particle diameter is most preferably 50 nanometers or smaller, to prevent the light diffusing sheet 1 from turning opaque white under the influence of a short wavelength. Since the averaged particle diameter of the fine inorganic filler 11 is preferably as small as possible, a lower limit thereof is not restricted and the general averaged particle diameter of the fine inorganic filler 11 is 5 nanometer or larger. The

averaged particle diameter of the fine inorganic filler 11 is derived by enlarging arbitrarily extracted 100 particles of the fine inorganic filler 11 by using a microscope to measure particle diameters and by simply averaging the measured particle diameters. When the fine inorganic filler 11 is not sphere-shaped, dimensions of particles of the fine inorganic filler 11 in an arbitrary direction and dimensions of particles of the fine inorganic filler 11 in a direction orthogonal to the arbitrary direction are averaged and the resulting averaged value is deemed as the particle diameter of the fine inorganic filler 11.

The amount of the fine inorganic filler 11 mixed into the light diffusing layer 5 is preferably 10 to 500 parts by weight for 100 parts by weight of the polymer component in the binder 7 and is more preferably 10 to 200 parts by weight. If the amount of the mixed fine inorganic filler 11 is less than the above range, thermal deformation of the light diffusing sheet 1 can not be satisfactorily avoided, whereas if the amount is more than the above range, the application of the resinous composition forming the light diffusing sheet 5 becomes difficult.

Although the rear surface of the base sheet 3 of the light diffusing sheet 1 is a smoothed surface,

the rear surface may be embossed to improve the light diffusing ability or the sticking-proof ability.

Figure 2 is a schematic view for explaining a structure of a backlight unit 13 into which the light diffusing sheet 1 of Figure 1 is incorporated. The backlight unit 13 comprises a lamp 15 as a source for generating light rays, a light guiding plate 17 disposed laterally of the lamp 15 for guiding the light rays emitted from the lamp 15 toward a front surface side, and a light diffusing sheet 1 provided on a front surface side of the light guiding plate 17. Although the light guiding plate 17 and the light diffusing sheet 1 are shown as being spaced from each other in convenience in Figure 2, the front surface of the light guiding plate 17 actually abuts with the rear surface of the light diffusing sheet 1.

In this backlight unit 13, first, the light rays 19 are emitted from the lamp 15 and guided to the inside of the light guiding plate 17. Then, the light rays 19 are reflected by reflection dots or a reflection sheet (not shown) provided on the rear surface of the light guiding plate 17 and are guided to the light diffusing sheet 1 provided above. Then, the light rays 19 are uniformly diffused when the light rays 19 pass through the light diffusing sheet 1 and

are delivered to a polarizer (not shown) provided above the light diffusing sheet 1.

In the backlight unit 13, the lamp 15 emits light and generates heat simultaneously. Thereby, the temperature around the lamp 15 becomes approximately 80 to 90°C For this reason, a region of the light diffusing sheet 1 in the vicinity of the lamp 15 (in the vicinity of a left end in Figure 2) is exposed to high temperature. However, the light diffusing sheet 1 has a less tendency to be deflected due to heat because the fine inorganic filler 11 is mixed into the light diffusing layer 5. Therefore, the luminance nonuniformity of the screen of the liquid crystal display is suppressed.

Figure 3 is a cross-sectional view in which the light diffusing sheet 21 according to another embodiment of the present invention is partially omitted. The light diffusing sheet 21 comprises a base sheet 3, a light diffusing layer 5 provided on a front surface side of the base sheet 3 and a sticking-proof layer 23 provided on a rear surface of the base sheet 3. The structures of the base sheet 3 and the light diffusing sheet 5 are identical to those of the embodiment shown in Figure 1.

The sticking-proof layer 23 is constituted by

a binder 25, resinous beads 27 dispersed into the binder 25, and a fine inorganic filler 29 dispersed into the binder 25. The materials of the binder 25, the resinous beads, and the fine inorganic filler 29 are identical to those of the light diffusing layer 5. The dispersion of the fine inorganic filler 29 into the sticking-proof layer 23 can increase the apparent crystallinity index of the light diffusing sheet 21. Therefore, the heat resistance of the light diffusing sheet 21 can be increased and the deflection of the sheet 21 can be suppressed. The thickness of the sticking-proof layer 23 (the thickness of the binder 25 except the resinous beads 27 that is represented by T2 in Figure 3) is not limited but is set to approximately 1 to 10 micrometers.

Since the amount of the mixed resinous beads 27 is relatively small, the resinous beads 27 are dispersed into the binder 25 as being spaced apart from one another. Many of the resinous beads 27 have lower end portions protruded from the binder 25. When the light diffusing sheet 21 is provided on the light guiding plate 17 (see Figure 2), the protruded lower ends of the resinous beads 27 abut with the surface of the light guiding plate 17. Therefore, the rear surface of the light diffusing sheet 21 does not

entirely abut with the light guiding plate 17. Thereby, the sticking of the light diffusing sheet 21 to the light guiding plate 17 is prevented and the luminance nonuniformity of the screen of the liquid crystal display is suppressed.

While in the light diffusing sheet 21, the fine inorganic fillers 11, 29 are dispersed into the light diffusing layer 5 and the sticking-proof layer 23, respectively, the fine inorganic filer 11 may be dispersed into the light diffusing layer 5, or the fine inorganic filler 29 may be dispersed into the sticking-proof layer 23. Alternatively, the light diffusing layer 5 may be formed by embossing, for example, instead of dispersing the resinous beads 9 and the fine inorganic filler 29 may be dispersed into the sticking-proof layer 23 without dispersing the fine inorganic filler 11 into the light diffusing layer 5. Off course, it is preferable that the fine inorganic fillers 11, 29 are respectively dispersed into the light diffusing layer 5 and the sticking-proof layer 23 to reliably suppress the deflection of the light diffusing sheet 21.

Hereinafter, the light diffusing sheet of the present invention will be described in detail according to examples, and the present invention is not to be

construed as limitation by disclosure of the examples.

[Example 1]

Into 100 parts by weight of acrylic resin (brand name "RUB medium clear" made by Dainichi Seika Industry Corp.) as a binder, 14 parts by weight of beads (brand name "NT-2" made by Nippon Oil Corp.) made of acrylic resin having an averaged particle diameter of 5 micrometers and 20 parts by weight of colloidal silica (brand name "Snow Tec" made by Nissan Chemical Corp.) having an averaged particle diameter of 0.015 micrometer were mixed and they were stirred by a stirrer to obtain a resinous composition.

The resinous composition was applied on a polyethylene telephthalate film (100 micrometer thick) as a base sheet at an application amount of 15g/m2 by a roll coating method and cured to form a light diffusing layer. The light diffusing layer is cut into a rectangular layer of 21 centimeters in a longitudinal direction and 15 centimeters in a lateral direction, thereby obtaining the light diffusing sheet of a first example. During a period between stopping of stirring and application, viscosity of the resinous composition was hardly changed and application operation was easy.

[Example 2]

The second example was identical to the first

example except that the colloidal silica was replaced by smectite (brand name "lipophilic smectite SAN" made by Cope Chemical Corp.) having an averaged particle diameter of 0.05 micrometer and 20 parts by weight of the smectite were mixed. Thereby, the light diffusing sheet of the second example was obtained. During a period between stopping of stirring and application, the viscosity of the resinous composition was increased and application operation was somewhat difficult.

[Example for Comparison]

A light diffusing sheet as an example for comparison was obtained on the same conditions except that the colloidal silica was not mixed thereinto. During a period between stopping of stirring and application, the viscosity of the resinous composition was hardly changed and application operation was easy.

[Evaluation of Heat Resistance]

The light diffusing sheets of the first example, the second example, and the example for comparison were incorporated into the backlight unit. The backlight unit was put into a temperature controlled bath of 60°C. The presence /absence of deflection of the light diffusing sheets was checked, 2 hours after, 4 hours after, 6 hours after, 8 hours after, 10 hours after, 24 hours after, 48 hours after,

and 72 hours after putting the backlight unit into the temperature controlled bath. The judgment of the presence/absence of deflection was made according to whether or not the luminance nonuniformity occurred on surfaces of the light diffusing sheets after lighting of the lamp of the backlight unit. This evaluation result is illustrated in the following table 1.

Table 1 Evaluation Result of Heat Resistance

		Example 1	Example 2	Example for Comparison
fine inorganic filler		colloidal silica	smectite	- - - - -
Viscosity		no increase	increase	no increase
presence/absence of deflection	2h after	Absent	absent	absent
	4h after	Absent	absent	partially present
	6h after	Absent	absent	present
	8h after	Absent	absent	present
	10h after	Absent	absent	present
	24h after	Absent	absent	present
	48h after	Absent	absent	present
	72h after	Absent	absent	present

As can be seen from the table 1, no deflection occurred on the light diffusing sheets of the first and second examples in which the fine inorganic fillers were mixed into the light diffusing layers. On the other hand, deflection occurred on the

light diffusing sheet of the example for comparison in which the fine inorganic filler was not mixed into the light diffusing layer, 4 hours after it was put into the temperature controlled bath. From this fact, it is shown that the mixture of the fine inorganic filler improves heat resistance of the light diffusing sheet, prevents deflection of the light diffusing sheet due to heat generated by the lamp, and suppresses the luminance nonuniformity of the screen of the liquid crystal display.

When comparison is made between the first and second examples, the increase in viscosity during a period between stopping of stirring of the resinous composition and application of the resinous composition is less in the first example. From this fact, it is shown that colloidal silica is preferable among the fine inorganic fillers to prevent degradation of workability.

[Industrial Applicability]

As described above, according to the present invention, the light diffusing sheet having a less tendency to be deflected due to the heat generated by the lamp and the backlight unit using this are obtained.

CLAIMS

1. A light diffusing sheet comprising:

a transparent base sheet; and

a light diffusing layer provided on a front surface side of the base sheet, wherein

the light diffusing layer is formed by dispersing resinous beads and a fine inorganic filler into a binder, and

the fine inorganic filler is colloidal silica.

2. The light diffusing sheet of Claim 1, wherein the resinous beads of the light diffusing layer have an averaged particle diameter of 1 micrometer to 50 micrometers and the fine inorganic filler of the light diffusing layer has an averaged particle diameter of not smaller than 5 nanometers and smaller than 1 micrometer.

3. The light diffusing sheet of Claim 1, wherein an amount of the fine inorganic filler mixed into the light diffusing layer is 10 parts to 500 parts by weight for 100 parts by weight of a polymer component in the binder.

4. A light diffusing sheet comprising:

a transparent base sheet;

a light diffusing layer provided on a front surface side of the base sheet; and

a sticking-proof layer provided on a rear surface side of the base sheet, wherein

the sticking-proof layer is formed by dispersing resinous beads and a fine inorganic filler into a binder, and

the fine inorganic filler is colloidal silica.

5. The light diffusing sheet of Claim 4, wherein the resinous beads of the sticking-proof layer has an averaged particle diameter of 1 micrometer to 50 micrometers and the fine inorganic filler of the sticking-proof layer has an averaged particle diameter of not smaller than 5 nanometers and smaller than 1 micrometer.

6. The light diffusing sheet of Claim 4, wherein an amount of the fine inorganic filler mixed into the sticking-proof layer is 10 parts to 500 parts by weight for 100 parts by weight of a polymer component in the binder.

7. A backlight unit comprising:

a lamp;

a light guiding plate disposed laterally of the lamp for guiding light rays emitted from the lamp to a front surface side; and

a light diffusing sheet according to any of Claims 1 to 6 disposed on a front surface side of the light guiding plate.

ABSTRACT

It is an object of the present invention to provide a light diffusing sheet that has a less tendency to be deflected due to heat generated by a lamp and a back light unit using this. The light diffusing sheet of the present invention comprises a base sheet and a light diffusing layer provided on a surface of the base sheet. The light diffusing layer is formed by dispersing resinous beads and a fine inorganic filler into a binder. It is preferable that the fine inorganic filler has an averaged particle diameter of not smaller than 5 nanometers and smaller than 1 micrometer. It is preferable that the amount of the fine inorganic filler to be mixed is 10 parts to 500 parts by weight for 100 parts by weight of a polymer component in the binder. As the fine inorganic filler, colloidal silica is used.

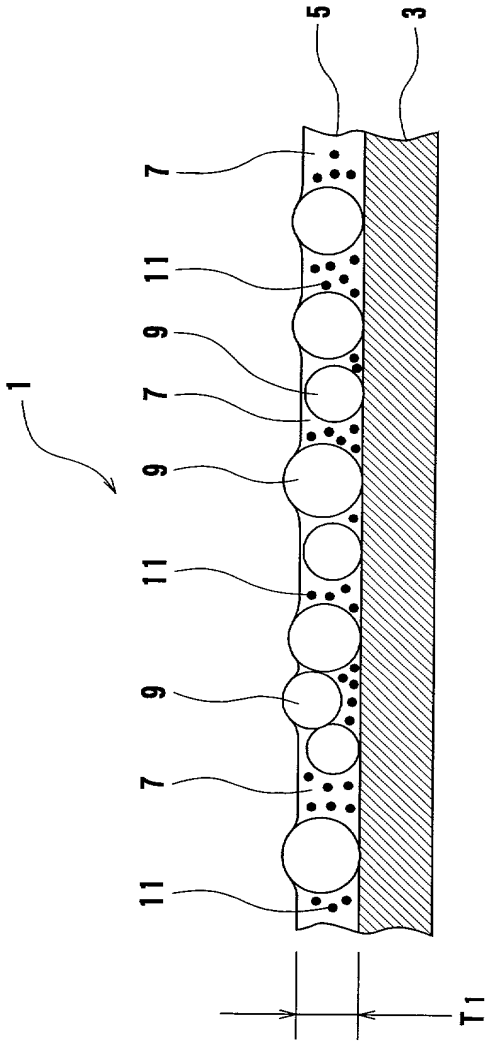

Fig. 1

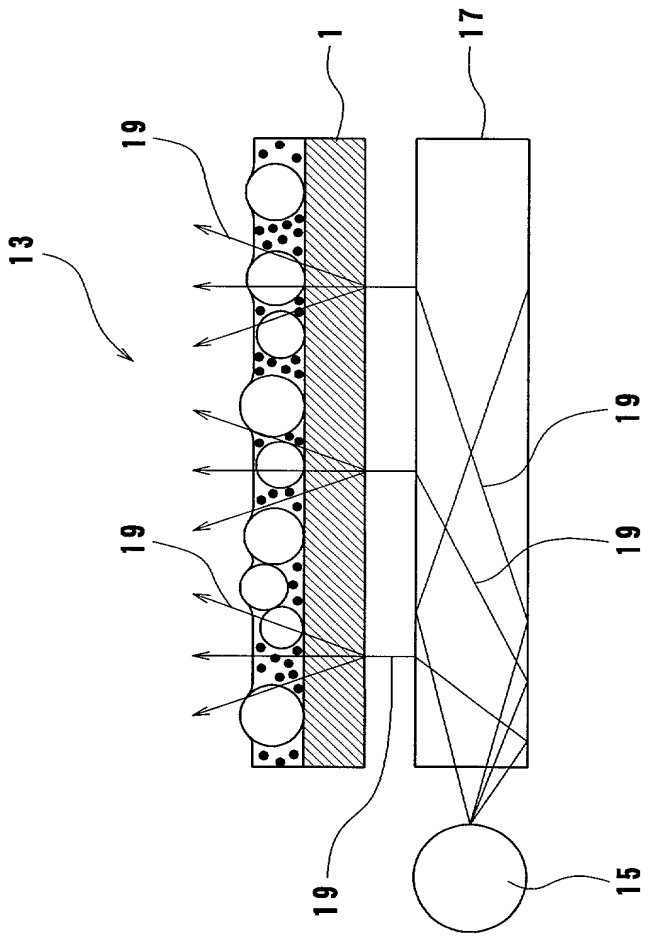

Fig. 2

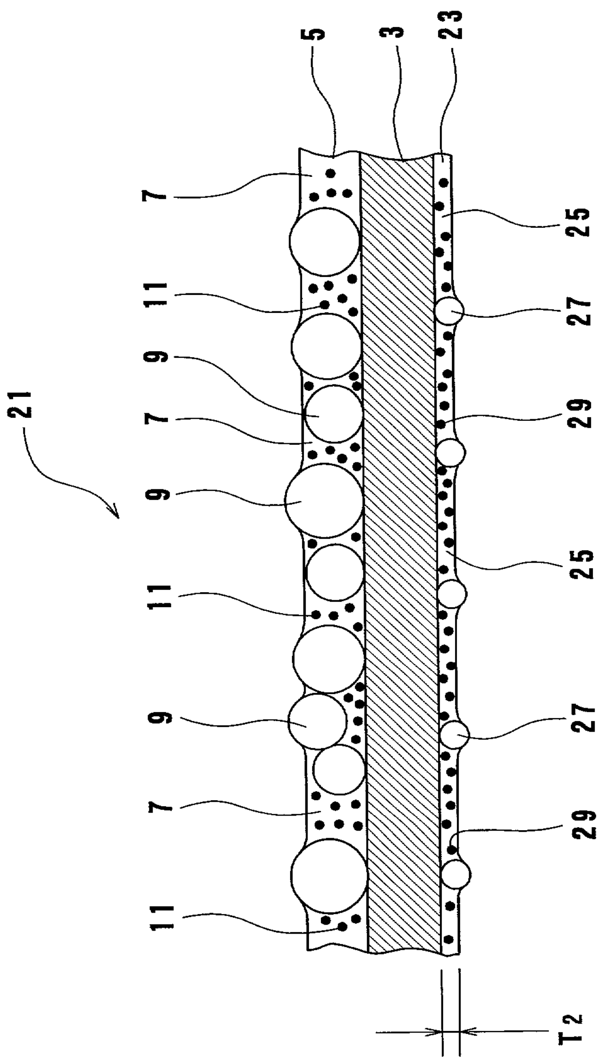

Fig. 3

DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name; I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled "**LIGHT DIFFUSING SHEET AND BACKLIGHT UNIT USING THIS**," the specification of which (check one): ☐ is attached hereto; ☐ was filed on _____ as Application Serial No. _____ and was amended on _____ (if applicable); ☒ was filed as PCT International Application No. PCT/JP99/04976 on September 10, 1999 and was amended under Article 19 on _____ (if applicable). I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) referred to above. I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in 37 C.F.R. §1.56.

I hereby claim foreign priority benefits under 35 U.S.C. §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

(Application Serial Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed ☒ Yes ☐ No
HEI 10-262631	Japan	17 September 1998	☒ ☐
			☐ ☐

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below:

(Application Serial Number)	(Day/Month/Year Filed)

I hereby claim the benefit under 35 U.S.C. §120 of any United States application(s) or PCT international application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior application(s) in the manner provided by the first paragraph of 35 U.S.C. §112, I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in 37 C.F.R. §1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

(Application Serial Number)	(Day/Month/Year Filed)	(Status-Patented, Pending or Abandoned)
PCT/JP99/04976	10 September 1999	Pending

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: I hereby appoint as my attorneys, with full powers of substitution and revocation, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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APPLICABLE RULES AND STATUTES

37 CFR 1.56. DUTY OF DISCLOSURE - INFORMATION MATERIAL TO PATENTABILITY (Applicable Portion)

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is canceled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is canceled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§ 1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) prior art cited in search reports of a foreign patent office in a counterpart application, and
(2) the closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentability defines, to make sure that any material information contained therein is disclosed to the Office.

Information relating to the following factual situations enumerated in 35 USC 102 and 103 may be considered material under 37 CFR 1.56(a).

35 U.S.C. 102. CONDITIONS FOR PATENTABILITY: NOVELTY AND LOSS OF RIGHT TO PATENT

A person shall be entitled to a patent unless --

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or

(c) he has abandoned the invention, or

(d) the invention was first patented or caused to be patented, or was the subject of an inventor's certificate, by the applicant or his legal representatives or assigns in a foreign country prior to the date of the application for patent in this country on an application for patent or inventor's certificate filed more than twelve months before the filing of the application in the United States, or

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraph (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent, or

(f) he did not himself invent the subject matter sought to be patented, or

(g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it. In determining priority of invention there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other.

35 U.S.C. 103. CONDITIONS FOR PATENTABILITY; NON-OBVIOUS SUBJECT MATTER (Applicable Portion)

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

35 U.S.C. 112. SPECIFICATION (Applicable Portion)

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.